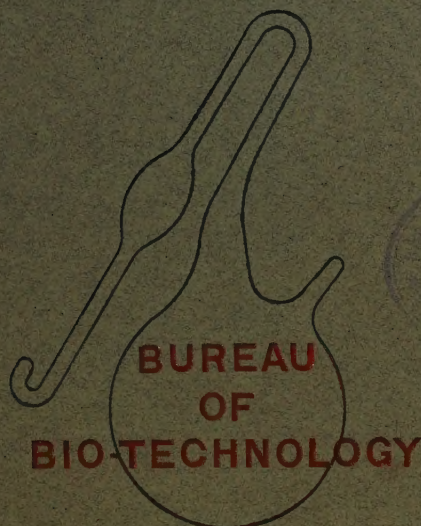

BULLETIN No. 8

□ JANUARY, 1923 □



CONTRIBUTIONS FROM THE
BIOLOGICAL, CHEMICAL
AND PHYSICAL RESEARCH

“ LABORATORIES OF ”

MURPHY & SON, LTD.

□ LONDON, LEEDS □
□ AND NOTTINGHAM □

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FOREWORD

WITH this issue the first volume of the *Bulletin* of the Bureau of Bio-Technology is brought to a close. In our first "Foreword" (*Bulletin* No. 1) the hope was expressed that the contents of the *Bulletin* would constitute a useful, if small, contribution to technical micro-biological science. The attitude of our contemporaries leads us to believe that some degree of success has been achieved in this direction. References to the *Bulletin*, long abstracts, and, occasionally, fully reproduced articles have appeared in the following Journals and other periodicals:—*Brewers' Journal*; *Brewing Trade Review*; *Journ. Institute of Brewing*; *Journ. Society of Leather Trades' Chemists*; *Journ. American Leather Trades' Association*; *Journ. Society Chemical Industry*; *Review of Applied Entomology*; *Experimental Station Record*, U.S. Dept. Agriculture; *The Fruit Grower*; *Le Cuir*; *Leather Trades' Review*; *The Leather World*; *Wool Record and Textile World*; *Dyer and Calico Printer*; *Revista Italiana del Cuoio dei Pellami*; *Wochenschrift für Brauerei*; etc. Requests for copies of the *Bulletin* have been received with a view to abstracting for the *International Review of the Science of Agriculture*, Rome, and for *Chemical Abstracts*, of the American Chemical Society.

Eight numbers have been issued at more or less regular intervals over a period of two years, and, in future, it is proposed to publish the *Bulletin* strictly Quarterly. The first number of Volume II. (*Bulletin* No. 9) will be issued at the end of March, 1923. Articles in hand for the new volume deal with the destruction of timber in mills, breweries, warehouses and other buildings, and its prevention; the suppression of insect pests and fungus diseases in relation to agriculture, malting, etc.; the organisms in beer deposits and their differentiation; micro-organisms in the leather industries; and other matters of industrial interest.

The subscription (7/6) for 1923 should be sent to Messrs. MURPHY & SON, LTD., Cedars Laboratories, Sheen Lane, Mortlake, London, S.W. 14.

MURPHY & SON, LTD.

January, 1923.

The Prevention of "Ropiness" in Beer from The Practical Point of View

IN this age of industrial competition and strife to make more and better products from a constant amount of raw material, the search for new raw materials, together with a laudable craving for "root knowledge," research becomes a vital necessity. Fortunately, the scientific spirit that impels an individual to institute research is not rare, and, not infrequently, it is so strongly developed as to lead to the pursuit of knowledge for its own sake. It must be remembered, however, that for every one who is satisfied with knowledge alone there are thousands ready to take utilitarian advantage of its teachings. Now, an investigator, whose intuition responds on the instant when experimental work has reached a stage at which its results may be made useful to the community, is, unfortunately, much more rare, and for that reason research is not always a paying proposition to a private firm incorporated for business purposes. It need hardly be emphasised that the work of this Bureau is mainly concerned with the discovery of facts of a practical, rather than of a theoretical nature.

As a rule, the public is not interested in research, but it is roused by the *results* of research in direct proportion to the applicability of those results to its own particular requirements. To realise to the fullest extent the truth of these remarks, one must attend a Trade Exhibition in the capacity of an investigator

of problems connected with the particular trade, or trades, represented, as did the writer recently, and this preamble is occasioned by his experience.

As in previous years, our Stand at the Brewers' Exhibition, held at the Royal Agricultural Hall, London, in November last, included exhibits illustrating the work of our Research Department. Among other exhibits, an investigation into the cause of a beer haze traceable to organisms derived from hops was illustrated by photographs and specimens. Something like 300 brewers realised for the first time that, except for the work in our own Laboratories, hops—a staple ingredient of their beers—had never before been systematically examined biologically. It would have stimulated the bio-chemical make-up of our nature to have been interrogated as to the formation of haze-producing bodies by micro-organisms, or with regard to their constitution, but the eminently practical question, "How can this trouble be avoided?" was the one that was invariably asked.

A series of specimens of fungi and bacteria derived from the atmosphere of breweries, and isolated from barley in the process of malting, aroused a good deal of interest. Again, our mycological spirit might have been cheered by questions as to the difference between the species *Rhizopus nigricans* and *R. Tritici*, their distribution in nature, or their comparison with regard to the secretion of diastase. The maltster who had seen his growing-floor over-run with mould in a single night gave a despairing shrug, the brewer sniffed the air for the odour of mould, and both asked, "How can you kill the 'blighters?'" After being shown miniature "wettings" of barley in dishes, one growing naturally and showing mould, and the other after treatment with an antiseptic, perfectly clean and free from any objectionable growth, our visitors appeared to leave perfectly happy with the knowledge that the "blighters" are not indestructible.

What proved to be a still greater attraction was a collection of specimens illustrating our investigations into the nature of one

of the organisms producing ropiness in beers, published in *Bulletins* Nos. 6 and 7, 1922. *Acetobacter R.*, the organism in question, was shown growing on various artificial culture media; in tubes containing solutions of different sugars designed to demonstrate the production of acid and gas, together with samples of beer that had become ropy after inoculation with the bacterium. Furthermore, it was shown how very real is the viscous body produced during the development of the bacterium in beer, by its precipitation into lumps, and, also, how these, after isolation from the beer, might be re-gelatinised in water or beer to reproduce a thick viscous liquid with properties in all respects similar to those of ropy beer.

The thick, dead, grey, oily character possessed by a ropy beer is, of course, the very antithesis of the brilliant, well-conditioned foaming appearance of a beverage which appeals to the palate through the eye, and there is no kind of difficulty which the brewer would not sooner meet than ropiness. Naturally, it was the *utilitarian* aspect of the research that remained uppermost in the minds of those who took an interest in this exhibit, because, *Acetobacter R.*, by any other name would prove just as disastrous in a cask or bottle of beer to which it gained entrance, and the burden of the final enquiry was, always, "How may it be prevented?"

In practice the onus of ropiness is nearly always thrown upon the condition of the plant. A lapse from that scrupulous cleanliness which ought to come very near to godliness in a brewery may be the means of allowing an accumulation of organic matter in a pipe, pump, or other portion of the plant, that will serve as a seat of infection. Now, infection is not necessarily the result of unclean plant. It has been demonstrated beyond doubt that the presence of *Acetobacter R.* may be due to air-borne infection, although its natural breeding-ground has not yet been certainly located. A beer may be produced by the most skilful manipulation, in the cleanest of vessels, yet, in its later stages, it may be ruined by the presence of ropy organisms derived from the atmosphere. It follows that if there is no way of controlling the incidence of this germ some means must be found to prevent its development,

and thus curtail its baneful activities. Investigation on this point is still proceeding, although valuable information has been already obtained, and in connection with our latest results much light has been concentrated on a fact about which we were previously quite in the dark.

About ten years ago, and after numerous laboratory experiments, we introduced into a brewery in connection with a haze trouble then under investigation a special form of liquid "finings" for use in the Tun during the course of fermentation. The haze referred to was due to some form of nitrogenous matter, uncoagulable on boiling, even with Copper Finings, the use of which is well known in the brewing trade. The composition of the new treatment was devised to augment substances occurring naturally in the beer and a considerable percentage consisted of *pure fermentation lactic acid*. Results obtained from this preparation were so satisfactory that it was made one of our staple products.* *Apropos* our present subject, however, the next interesting development commenced with the receipt of a letter from one of its principal users, who stated that since using it they had entirely escaped their former trouble due to ropiness, to which they had been subject for many years.

We are bound to admit that our appreciation of this property was accompanied by surprise. Trials were then made with no other object than that of preventing ropiness, and it continued to give excellent results. Later, without any alteration in composition, it was added directly to the finished beer, and in no case has ropiness been known to develop after such addition. The main reason for this rope-preventing property may be found in our notes on experiments made during our research on *Acetobacter R*. Several substances were introduced into beers after inoculation with the organism, and the results are tabulated in *Bulletin* No. 7, *Bur. Biotec*, 1922, p. 206, from which it will be seen that the only substance among those mentioned which inhibited the development of the ropy organism was *lactic acid*.

Thus it has been established that, previous to these researches, our practice in dealing with the prevention of ropiness, at first

*N.D.B. No. 2.—See "The Production of Naturally Conditioned Non-Sediment Beer without Appliances," published by Murphy & Son, Ltd.

purely empirical, was scientifically sound. Whether other substances incorporated with the lactic acid may have had contributory controlling effect, or not, still remains to be determined, but, pending further investigations, we are satisfied to go on using our product for the purpose.

The problem of recovering a beer already ropy is not yet solved. There are many serious difficulties to be overcome, and these are as well appreciated by the brewer as by the investigator, but so long as ropiness can be prevented the need for a cure is not so acute.

There are, of course, other precautionary measures that may be taken against the risk of infection. Chief of these, perhaps, is attention to the cleanliness of containers. Bottles should be cleansed with scrupulous care, and the efficiency of bottle washing and filling machinery calls for strict attention. Much depends upon the condition of carriage casks. These, being constructed of wood, suffer from a primary inherent defect—porosity. The innumerable pores of the wood offer special facilities for the reception and retention of mould spores, yeasts, *torulae* and bacteria, together with sufficient organic matter to provide them with nutriment when the cask is empty. These organisms have been found to a depth of half a centimetre in cask wood, and only excessively long steaming, such as would destroy the nature of the wood, will raise the temperature at that depth sufficiently high to destroy the organisms. For this reason the steaming of casks, in practice, does not render them sterile. If a cask is shived immediately after steaming and allowed to cool down, drops of water, representing the condensed steam, collected and transferred to a Petri dish containing sterile nutrient gelatine, invariably produce a crop of organisms. Although, at the moment of condensation, the water drops would be sterile, contact with the pores of the wood immediately results in contamination.

Chemical disinfectants are no better unless prolonged contact is possible, as they fail to penetrate into the pores, and many of them are detrimental to the structure of the wood. The only satisfactory method of preventing infection in this case is to remove

the cause. The germs within the pores cannot be removed, but their influence can be avoided by first sterilising the surface and then immediately filling the pores with a lining preparation. The best material for this purpose, apart from the question of elasticity, odour and taste, is the one that will penetrate furthest into the pores. Not all linings possess this property to any marked degree, and it is only a waste of both material and labour to coat casks (or fermenting vessels) with substances that do not fulfil this fundamental requirement. Sooner or later, in either case, the surface layer of such a lining will wear off, but so long as the pores remain plugged it is immaterial whether a superficial covering exists or not.



FIG. 17.
SECTION OF OAK STAVE SHOWING SURFACE LAYER AND
INFILTRATED WEDGES OF DUKERON.

The accompanying illustration, Fig. 17*, is a photomicrograph of a section of a cask stave treated in accordance with the necessary requirements, and it constitutes, perhaps, a more eloquent argument for what has been said in this connection than any other evidence that could be brought forward.

F. A. MASON.

*Reproduced from our brochure, "Dukeron and the care of Brewery Plant."

The Suppression of Insect Pests and Fungoid Diseases

2. THE FUMIGATION AND DISINFECTION OF GLASSHOUSES

MANY growers do not realise the importance of Glasshouse Sanitation, and of those who partially realise the need, many do not put their ideas into practice, yet the necessity for thorough cleansing should surely be obvious.

An important factor often omitted from our considerations, but, nevertheless, of great moment, is the adaptability of insects and fungi to environment. For instance, the Red Spider is generally associated with hot, dry climatic conditions, but during the early part of the year this pest has been observed during frosty weather "carrying on" quite gaily in a cold well-ventilated house, whilst in another district the same pest has been noticed on young cucumbers in the newly-planted borders growing under conditions usually found in a moist stove.

Fungi are supposed to favour a warm and humid atmosphere as optimum conditions for their growth and multiplication; yet it is not uncommon to find rusts, stem-rots, etc., on plants under glass grown in cold and comparatively dry surroundings.

The adoption of preventive measures against pests and diseases should not be regarded in the light of an uncertain speculation, but preferably considered as an "Insurance Against Loss of Crop."

It has been observed in other phases of life that "where there is no dirt there is no disease," and this statement can be well

applied to plant life. It is necessary to periodically clean down a human habitation, but it is not less necessary to either spring- or autumn-clean the plant-house. It is more economical in the long run and produces better results. A matter of keeping a house empty for a few days may save the grower many anxious moments and a considerable amount of cash.

After a crop of tomatoes, for example, has finished, the haulm, roots and other refuse should be removed to some suitable spot where, instead of being allowed to rot and left so that the winds can disperse and disseminate bacteria and fungoid spores, the refuse should be burnt. The burning process eliminates a great source of infection by destroying insect eggs, hibernating creatures, and—perhaps of greater moment—the adhering spores and mycelium of many fungoid diseases.

When the house is to be planted again immediately with another crop, time will not allow for the soil to be sterilised. This, however, should be done at least once in twelve months by the use of a suitable soil steriliser, preferably a fortnight before planting out the borders.

Attention should next be directed to fumigating and disinfecting the house. Unfortunately, the number of substances at our disposal which would serve the twofold purpose are very limited indeed, and it therefore requires a double operation. Fumigation, as a process, is scientifically sound as verified by users of "ALVESCO" WHITE FLY FUMIGANT, because it involves the use of a blend of toxic vapours or gases which can permeate all parts of the house by reason of the ease with which it mixes with air; and the efficiency of a fumigation, therefore, depends upon the rate at which the gas will intermix with air and upon the time allowed for diffusion. The toxicity or insecticidal value of the fumigant, together with its rate of evaporation if a liquid, are, needless to say, of equal importance, and any fumigant for fumigating empty houses must not only kill the hibernating insects, but also the eggs. It is extremely doubtful if cyanide gas, nicotine and the commoner fumigants fulfil the latter purpose,

but successful results have been obtained with "ALVESCO" GLASSHOUSE FUMIGANT, one of the active ingredients in this case being a chlorinated nitro compound. It has been shown, for instance, that "Red Spider" and the eggs of "White Fly" are apparently unable to withstand the effects of the latter fumigant, whilst caterpillars, scale, aphids, wood-lice and noxious weeds suffer a like fate.

There is one outstanding advantage in fumigating an empty house. The fumigant can be used at a far greater strength without the fear of damage which would otherwise prove disastrous if used in the presence of plant life at the same concentration. Glasshouse conditions, generally speaking, are ideal for the growth and multiplication of fungoid diseases, and the regulation of temperature and humidity are no doubt the main controlling factors. There is, however, another point often left out of general considerations, namely, that as a result of extensive cross-breeding and intensive cultivation many of the newer varieties of plants have had to sacrifice stamina and vitality for beauty and other advantages.

The disinfection of the house is perhaps in some respects more important than fumigation, because of the fact that insects are known to act as carriers of fungoid spores and bacteria, and, as previously stated, the conditions prevailing in the house are usually ideal for the germination of the latter. Given these conditions, it is probable that the fungi will multiply with greater rapidity than insects.

Hence the necessity for preventive measures to eliminate, as far as humanly possible, all centres of infection; and for obvious reasons one of the main features in any system of treatment is to ensure that only clean plants are brought into the house.

We have found from experience that the following preventive measures have given very satisfactory results, and which are practiced by many of the growers in various parts of the country.

Removal of debris.—Before removing dead haulm, etc., the house should be thoroughly fumigated as previously indicated to

destroy any adhering pests. This fumigant will kill any weeds or other plants as well as insects.

The débris should then be removed and burnt in an incinerator. The soil should next be sterilised—this may be carried out either by steam or dry heat or by chemicals applied to the soil.

In certain districts, heat sterilisation is favoured. In the case of steam, a perforated grid is buried in a heap of soil and steam is injected for a short time. This method gives results which are quite satisfactory providing the resultant plant growth can be suitably controlled, as the nitrifying organisms multiply extremely rapidly, giving rise to sappy succulent growth.

Dry heat sterilisation is usually carried out in a direct-fired "furnace," somewhat similar in construction to a miniature "blast furnace." The soil is fed by means of a hopper supplied by a bucket elevator and is heated to a temperature of about 200°F. for about 24 hours. This temperature is evidently insufficient to destroy all organic life, but apparently kills most of the organisms which are malignant to plant life, as well as those which may be looked upon as causing many plant diseases. Undoubtedly, many fungoid spores are also killed at this temperature.

Chemical Sterilisation.—This method has many advantages over the former, owing to the fact that no apparatus is required in the operation. Again, the material, if properly applied, comes into intimate contact with the upper layers of soil. The partial sterilising effect is therefore much more uniform.

The ideal steriliser is, of course, one which will destroy malignant and disease organisms and, in addition, soil pests such as Eel-worm and Julus-worm.

A considerable amount of cresylic acid has been used for this purpose, but whilst this material is a good sterilizer, it does not destroy Eel-worm, etc. Recent developments in soil research have shown the value of chlorinated compounds such as chlorcresol, chloropicrin, etc., as being much more effective than ordinary cresylic acid.

House Cleansing.—It is obviously essential to bring clean plants into a clean house; therefore, after soil sterilisation, interior surfaces should be thoroughly disinfected to destroy any hibernating insects and spores.

The brick walls particularly offer hibernating quarters for all and sundry pests owing to the many cracks and crevices.

It is therefore very desirable to destroy moss, lichen and other low forms of plant life with lime-wash containing 1 per cent. Sporocide, which is a very powerful, non-volatile insecticide and fungicide.

All plant diseases should be treated as infectious, and it is therefore important to remove all sources of infection.

Seed-boxes, pots, sticks, canes, staging and tools should be thoroughly treated with a powerful combined insecticide and fungicide, such as the Alvesco Formaldehyde Compound, or they may be stoved in a suitably-constructed oven, utilising the waste heat from the furnaces at a temperature of 200–250°F.

It might be suggested by the sceptics that this treatment is far too expensive and impracticable. Such precautionary measures, however, are carried out by many growers in this country and are known to pay in the long run. Although the treatment might be considered drastic, it is not uncommon to find a few struggling forms of life which have managed to survive, and it must be remembered that these, unless exterminated in the early stages, will produce progeny during favourable conditions, perhaps leading to the appearance of either pests or disease in epidemic proportions during the subsequent season. Until horticulturists realise that (1) our pests are surely gaining on us, (2) that they are capable of adapting themselves to varying conditions and becoming firmly established, (3) that pest control must be carried out in a scientific and predetermined manner, and (4) that only by co-operating with and utilising the technical services of the scientific workers of the country in the great battle, can we ever hope to accomplish the desire of all—the production of clean crops on a competitive basis with other countries of the world.

T. PARKER.

Acidity of Tan Liquors

from the

Bacteriological Point of View

THE acidity of the liquors which is essential to successful tannage has been the subject of enquiry from several standpoints. But beyond the work of Andreasch in 1897 the bacteriological considerations have received little attention, and we have not made the amendments to those early statements for which recent progress in bacteriological knowledge calls.

A most prevalent impression is that the acidity is due to the formation of acetic acid by "acetic acid" bacteria through the oxidation of alcohol. This, of course, necessitates previous production of alcohol by other bacteria or yeasts through the fermentation of sugars. Undoubtedly this process does occur, but it should also be borne in mind that species of *Acetobacter* oxidise glucose to gluconic acid, and so may be responsible for an increase of acidity in the absence of alcohol. A property common to most members of this group of organisms is the ability to oxidise acetic acid to carbon dioxide and water if other suitable carbohydrates are not available.

The suggestion of Andreasch that putrefactive bacteria survive the acid reaction of the tan liquors and, hydrolising hide substance, provide for the nitrogen requirement of the acidogenic organisms is not substantiated. The putrefactive organisms—*Subtilis*, *Proteus* and *Mesentericus* groups—are peculiarly sensitive to acid. The acid limit of *Proteus* has been given as pH 6.5 and of *Subtilis* pH 4.2. Furthermore, animal protein is not an essential source of nitrogen for either the acetic or lactic acid bacteria; on the contrary, both groups of organisms thrive better upon a vegetable medium. Members of the *Acetobacter* genus will grow well in an infusion of hops alone. In the commercial production of lactic acid it is not usually found necessary to add protein other than

that already present in the cereals employed. Again, although the brewer does not add protein to the wort, his ever-present trouble is the prevention of activity of acid-forming bacteria such as are present in the tan liquors. Beijerinck in his study of acetic acid bacteria showed that many of these organisms are able to derive their nitrogen from ammonium salts.

Janke has evolved the following classification of the acetic acid bacteria :—

- 1 HAPLOTROPHIC; acetic bacteria which grow at the expense of ammonium salts and acetic acid.
 - A. *Schützenbach* group, with Beijerinck's *Bacterium aceti* (Pasteur) and Henneberg's quick vinegar bacteria.
 - B. *Hansenianum* group, comprising types of moderate acidifying power, which grow in mineral solutions, but differ from those of group A in cell form and in the formation of filamentous or mucilaginous surface growths.
- 2 SYMPLOTROPHIC; which do not grow at the expense of ammonium salts and acetic acid.
 - A. *Rancens* group, comprising types which do not form gristly films nor give a blue colouration with iodine on treating the mucilaginous matter.
 - (a) Sub-group of *Bacterium aceti* HANSEN, immobile.
 - (b) Sub-group of *Bacterium aceti* BROWN, mobile.
 - (c) Sub-group of *Bacterium albuminosum* LINDNER, forming filamentous, slimy masses in films at the bottom of culture liquids.
 - B. *Pasteurianum* group, yielding mucilaginous matter which is coloured by iodine.
 - (a) Sub-group with mobile cells.
 - (b) Sub-group with immobile cells.
 - C. *Xylinum* type, forming films of cartilaginous or gristly character.

Another group of bacteria connected with the production of acid in tan liquors is the lactic acid group. We recognise as "lactic acid" bacteria organisms which are usually Gram positive and frequently thermophilic, and which ferment some of the sugars—disaccharoses and hexoses, with the formation of lactic acid almost exclusively of other compounds.

The so-called "lactic acid" bacteria which occur in tan liquors seem to constitute a group of organisms which, although obviously quite nearly related to the typical *Lactobacillus*, have not received the attention of the general bacteriologist. Their Gram reaction is somewhat variable, very few indeed are thermophilic, and most of them appear to grow best at about 25°C. They have not ordinarily any diastatic property; neither have the true *Lactobacilli*. It is most important for us to ascertain what group of organisms is responsible for the conversion of the starches of the tanning material into sugars. Species of moulds, particularly of *Mucor* and *Aspergillus*, are generally present and are no doubt largely responsible, but of the part played by bacteria in this respect we know very little.

A further group of bacteria which requires to be considered is the *Coli-aerogenes* group. Although this group has received little previous attention in this connection, it is nevertheless important. It is an extensive group of organisms with very general fermentative properties which merges into the *Coli-typhoid* group on the one side and possibly the *Proteus* group on the other. Most species split up protein matter producing indol. *Bacterium aerogenes* and *Bacterium cloacæ* are types of species which one has isolated from tan liquors; the latter liquefies gelatin, but other members of the group do not, as a rule, do so. An acidity beyond pH 4.5 will probably preclude the activity of coliform organisms. The product of fermentation in this case is a mixture of acetic and lactic acids, small amounts of other organic acids and alcohol, together with hydrogen and carbon dioxide.

P. HAMPSHIRE.

Spray Spreading Agents

IN the United States during the past few years Spray Spreaders have received a considerable amount of attention, both by the scientific worker and by the grower, with the result that where "Dry Dusting" is not the common practice these important materials have become part and parcel of the process of commercial spraying.

In this country the subject has certainly not reached such an advanced stage, and, in consequence, large quantities of liquid insecticides are annually wasted through the inefficient manner in which they are spread over the leaf surface and come into contact with the pest.

The principle with which the subject of spray spreading is chiefly concerned is that of the surface tension. The molecules in the interior of a liquid exert their attractive forces equally in all directions, but those on the surface, being attracted in one direction only, give rise to a force, known as "surface tension," which is generally compared with the force which would be exerted by a stretched elastic film enclosing the liquid. The tendency of this force is to diminish the surface area and to cause the liquid to assume a spherical shape. It follows that reduction of the surface tension will produce a corresponding decrease in this tendency, with the result that the same volume of liquid will cover a larger surface, by forming a film, instead of a number of drops. The importance of this in spraying operations is obvious, since certain substances are known which possess the power of decreasing the surface tension of liquids.

Various materials have been used in the past to increase the "spreading" of a spray fluid over the foliage. These have included soap, saponine, quillaia bark, glue, borax, etc. Owing, however, to the chemical reaction which may take place between soap and

some of the materials used as Insecticides and Fungicides, its universal application is thereby somewhat restricted, and, in addition, to produce the desired results it is necessary to use a fair quantity.

Saponine, in many respects, gives excellent results under certain conditions, but is far too expensive to be a commercial proposition from the grower's point of view. The remaining materials, although not so expensive, give results of greater or less efficiency, and will not be further considered here.

The alkaline caseinates, among other substances, were investigated at our Testing Station this year, special attention being devoted to calcium caseinate.

This substance was used by Peterson some years ago in the United States with lime sulphur, as an insecticide, but it is doubtful if this combination has been used on a large scale as a fungicide until comparatively recently.

Salmon and Horton,* early this year, published an account of some experimental work using a factory-boiled lime-sulphur and calcium caseinate for controlling Hop Mildew.

The results of their work are tabulated below :—

	Strength of Lime Sulphur.	Per Cent. of Polysulphide Sulphur.	Per Cent. of Calcium Caseinate.
A	1-99	·16	1 per cent. }
B	1-149	·11	1 per cent. } Fungicidal
C	1-199	·08	1 per cent. Doubtful

It was observed that with A and B the patches of mildew were killed outright in 24 hours, while the control sprayed with calcium caseinate alone was as vigorous as before. It was also found that similar results were obtained using 1·5 per cent. calcium caseinate instead of 1 per cent.

* *Journ. Min. Agric.*, 28, 1922, p. 995.

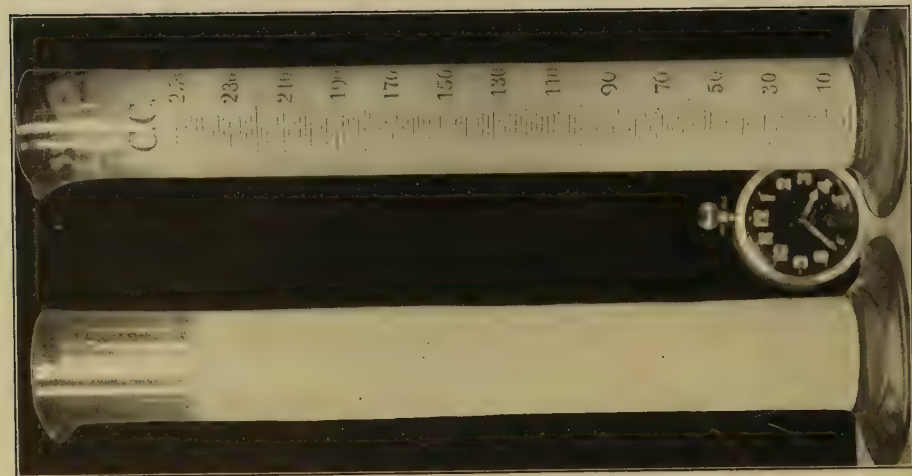


FIG. 1.

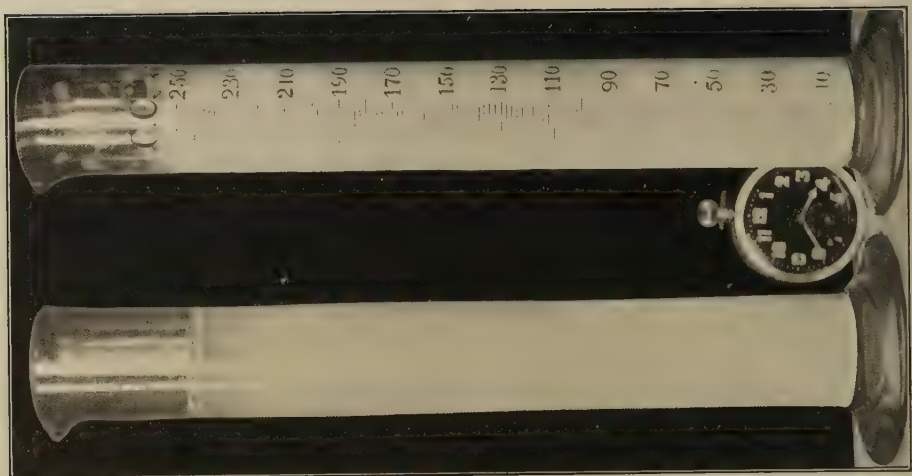


FIG. 2.

LEAD ARSENATE SUSPENSION WITHOUT (LEFT), AND WITH 0.2 PER CENT. CALCIUM CASEINATE (RIGHT).



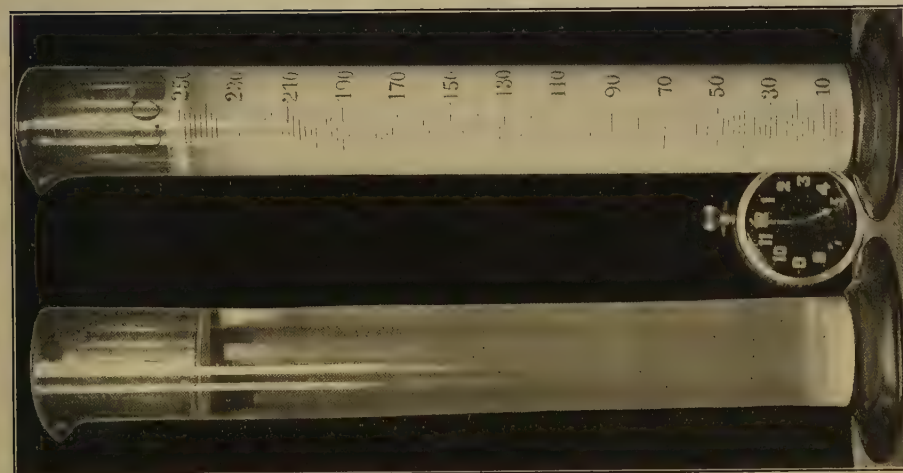


FIG. 3.

LEAD ARSENATE SUSPENSION WITHOUT (LEFT), AND WITH 0.2 PER CENT. CALCIUM CASEINATE (RIGHT).

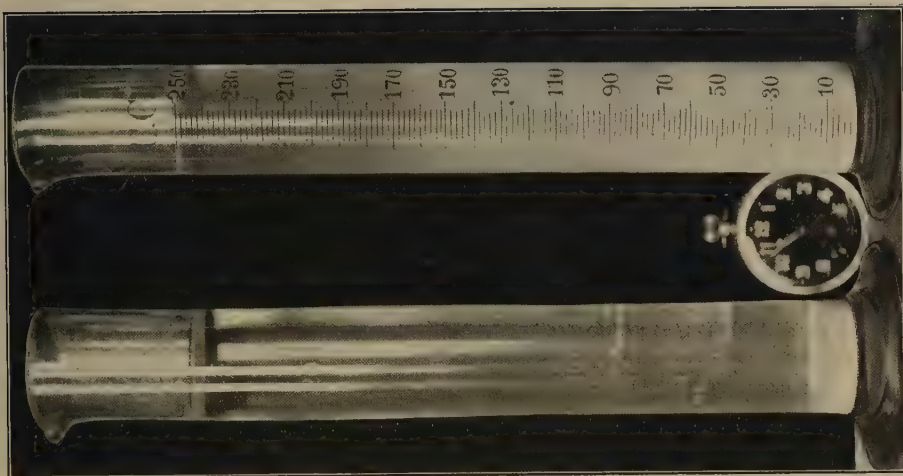


FIG. 4.

The results of our own experiments showed that a 0.2 per cent. solution of calcium caseinate appeared to be the lowest strength required to reduce the surface tension to a minimum and give a maximum spreading and wetting effect.

EXPERIMENTAL.

Two sheets of glass of equal size were highly polished after washing with caustic soda to remove grease. These were sprayed at equal distances with lime sulphur solution 1 in 20, with and without 0.2 per cent. of calcium caseinate. The plates were secured in a vertical position and the same pressure as far as possible maintained in each case. The plates were then allowed to drain and dry and were finally photographed. The results shown in the accompanying illustrations, Figs. 22 and 23, are self-explanatory.

Similar experiments were carried out with ammonium polysulphide solution at 1-100 dilution, arsenate of lead 4 lbs. to 100 gallons, liver of sulphur and nicotine petroleum emulsion, with similar results as seen in Figs. 20 and 21.

A further set of experiments with lime sulphur, ammonium polysulphide solution, liver of sulphur and arsenate of lead was performed as follows:—

A thin film of the diluted solutions, with and without 0.2 per cent. calcium caseinate, was produced on a microscope slide, the latter being then well drained and allowed to dry in a horizontal position. Photographs of these deposits are shown in Figs. 18 and 19.

It will be observed that the particles of sulphur and arsenate of lead are much closer together in the case of the solution with 0.2 per cent. calcium than in that without, suggesting that the spreader has some influence upon the deposition of particles from solution and suspension. The practical value of this is obvious, as the spreader causes the spray to cover a larger area and form a thinner film, and as the particles of the active ingredients are deposited closer together one would expect greater insecticidal and fungicidal efficiency from a given spray fluid.

An experiment was next carried out to ascertain the effect of calcium caseinate upon the rate of settling of a suspension of arsenate of lead.

1. A suspension of arsenate of lead at the rate of 4 lbs. to 100 gallons of water was placed in one cylinder.
2. A second suspension at the rate of 4 lbs. to 100 gallons aqueous solution of calcium caseinate was placed in another cylinder.

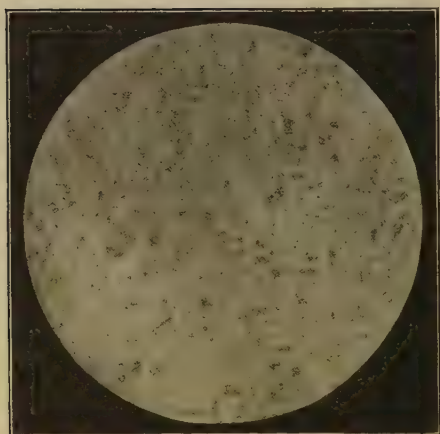


FIG. 18.

DEPOSIT OF LEAD ARSENATE SUSPENSION WITHOUT
CALCIUM CASEINATE.

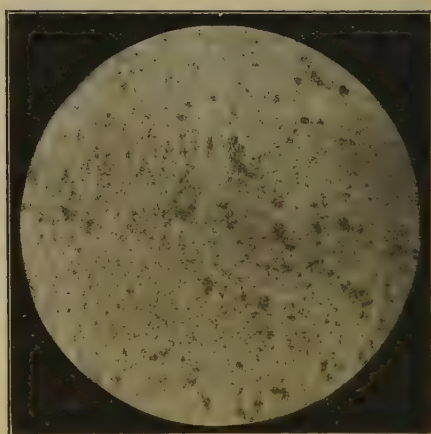


FIG. 19.

DEPOSIT OF LEAD ARSENATE SUSPENSION WITH
0.2% CALCIUM CASEINATE.

These were carefully shaken simultaneously for one minute, allowed to stand, and then photographed at intervals.

It will be seen from the reproductions, Figs. 1—4, Plate 8, that in five minutes there was evidence of sedimentation, and after a quarter of an hour the arsenate in the first suspension had nearly all settled out; at the end of one hour complete settling had taken place, while in the calcium caseinate solution, the arsenate was still showing excellent suspension six hours later.

These results show the great advantage of using calcium caseinate with arsenate of lead: it not only increases the wetting and spreading properties of the insecticide, but obviates the necessity of very elaborate stirring gear in the spraying machine and thus ensures the equal distribution of the poison over the orchard, providing the operator carries out this work in an efficient manner.

A number of experiments on different kinds of foliage was carried out by spraying specimens with and without the addition of calcium caseinate to the spray fluid.

It was observed that foliage having a polished and smooth surface, such as Ivy, Apple, etc., was covered with a uniform and unbroken film in the case of lime sulphur and calcium caseinate, but was spotted when sprayed with lime sulphur alone.

Attention was next directed to leaves having a spiny surface, such as Hop and Marrow, but the fluid, either with or without the spreader, appeared to collect in globules on the apex of the spines. The amount of leaf surface covered seems to depend on the proximity of the spines to one another and to the extent of their distribution over the leaf surface. As was expected, an increase in pressure on spraying produced a better covering with the spray.

Attention was also directed to the influence of calcium caseinate upon the spreading of lime sulphur and other washes over leaves having a heavy waxy bloom on the surface, such as Carnation, Savoy and Cabbage, and it was found that the spreader had little effect in increasing the spreading, the effect being in fact little better than that produced with the spray itself. This, no doubt, explains the difficulty experienced in controlling Red Spider on Carnations, and suggests that dry dusting would, in this case, produce better results than wet spraying.

Other experimental work has shown that Apple Scab can be controlled with lime sulphur at 1 in 160, used in conjunction with calcium caseinate, without defoliation or russetting.

American Gooseberry Mildew can similarly be controlled without defoliation or disfigurement of the fruit resulting.

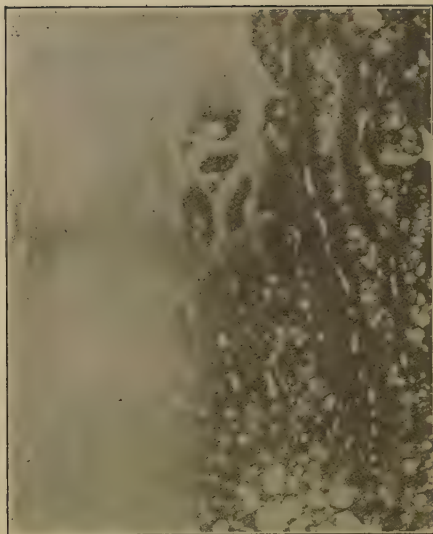


FIG. 20.
AMMONIUM POLYSULPHIDE SOLUTION
WITHOUT CALCIUM CASEINATE.

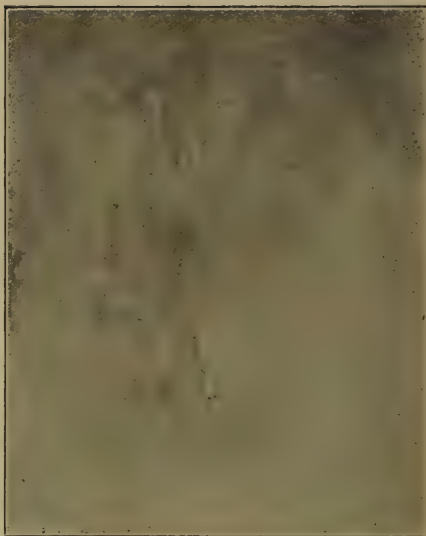


FIG. 21.
AMMONIUM POLYSULPHIDE SOLUTION
WITH 0.2% CALCIUM CASEINATE.

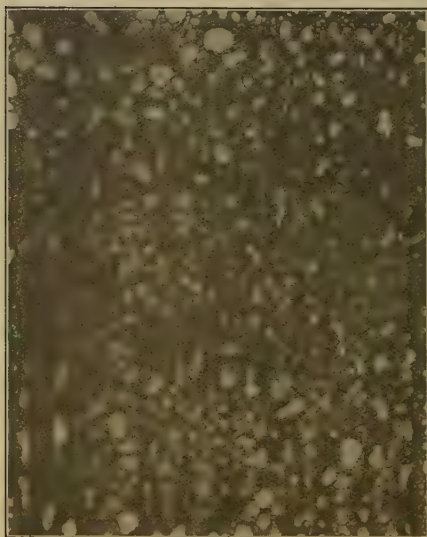


FIG. 22.
LIME SULPHUR SOLUTION WITHOUT
CALCIUM CASEINATE.

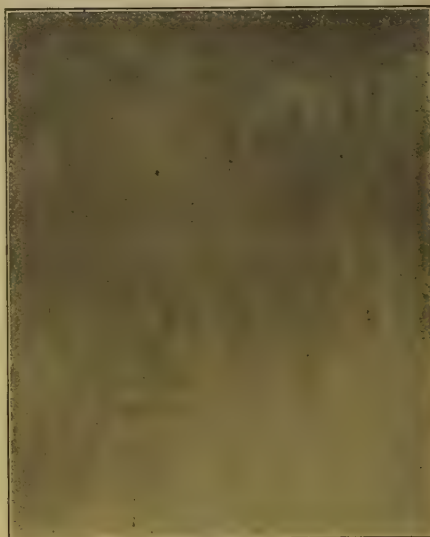


FIG. 23.
LIME SULPHUR SOLUTION WITH
0.2% CALCIUM CASEINATE.

During the past season a series of experiments was carried out using Nicotine Petroleum Emulsion for controlling Red Spider on Cucumbers, and it was observed that at a dilution of 1 gallon to 160-200 gallons of a 0.2 per cent. calcium caseinate solution the pest was successfully controlled, without the production of any deleterious effects upon the plants.

This wash, without the spreader, had been previously used at 1 in 80 and 100, especially for Capsid Bug on Apple, but in conjunction with the spreader this year it has been used successfully on a large scale at 1 in 160, thus increasing its value by 100 per cent.

SUMMARY OF RESULTS.

1. Calcium caseinate greatly increases the wetting and penetrating power of a wash, and, in consequence, the active ingredients come into closer and better contact with the leaf and with the pest; the maximum effect (whether insecticidal or fungicidal) is thus obtained.
2. A 0.2 per cent. solution of calcium caseinate is approximately the lowest strength which will produce maximum wetting.
3. Calcium caseinate appears to influence the deposition of particles from solution and suspension, causing them to be deposited in closer proximity to one another.
4. It greatly retards the settling of Arsenate of Lead from suspension.
5. It apparently increases the insecticidal and fungicidal efficiency of some washes by 100 per cent. when these are compared with similar concentrations in ordinary water.
6. It might be used with great advantage for assisting the penetration of washes in the control of Woolly Aphis.
7. The results of the experiments suggest that winter washing with lime sulphur in conjunction with calcium caseinate might be successfully carried out at a dilution of 1-40 instead of at the present winter strength of 1-20.

T. PARKER AND A. W. LONG.

Potato Trials, 1922

THE experiments of 1921 (*Bull. Bureau of Bio-Technology*, No. 7, p. 224) having shown that Arran Comrade gave the most satisfactory result on the soil of the Testing Station, the trials this year have been devoted to a comparison of the effects of various sterilisers on the yield of this particular variety.

Six plots of similar areas were planted on May 11th and 12th with seed at the rate of $18\frac{1}{2}$ cwts. per acre, the average weight of each set being 2.15 ozs. On May 15th the plots were dressed with the sterilisers, in powder form, at the rate of 5 cwt. per acre. In spite of the drought at the commencement of the season the plants did well, the haulm again being luxuriant although not so vigorous as last year. It was also noticed that the tops died off much earlier in the year, whereas in September, 1921 (when the previous crop was lifted), the haulm was still green.

The plots were treated as follows:—

Plots.

No. 1. Control.

No. 2. Steriliser No. 2 Spread broadcast and
dug in at the rate of 5 cwt. per acre

Containing .38% Tar
acids in a crude base.

No. 3. „ No. 4 „ „ „ Consisting of pure
Naphthalene.

No. 4. „ No. 5 „ „ „ Containing $7\frac{1}{2}\%$
Chlorophenols in
crude base.

No. 5. „ No. 6 „ „ „ Containing 2% of
organic Hypochlorite
in crude base.

No. 6. „ No. 7 „ „ „ Containing 25% Tar
Acids in crude base.

The results obtained are shown in the following tables :—

<i>Yield per acre.</i>				<i>Yield per 100 lbs. seed.</i>		
			Tons.	Cwts.		
Plot 1.	Control Plot	...	7	9	...	889 lbs
Plot 2.	Treated with Ster.	No. 2	7	10	...	893 "
Plot 3.	"	No. 4	7	4	...	855 "
Plot 4.	"	No. 5	6	18	...	823 "
Plot 5.	"	No. 6	8	3	...	978 "
Plot 6.	"	No. 7	8	6	...	987 "

OBSERVATIONS ON TRIALS.

1. The tubers dug up from the treated plots were on the average larger in size than those obtained from the "Control."
2. The incidence of disease was also much less in the treated plots as compared with the "Control."
3. In Plots 5 and 6, where the organic Hypochlorite and high concentration of Tar Acids was used, disease appeared to be entirely absent.
4. Sterilisers 6 and 7 appear to moderately increase the crop as compared with the untreated "Control," and the results suggest that soil treatment on a large scale might be adopted with advantage.

The analysis of the soil in which the potatoes were grown is shown below :—

<i>Mechanical Analysis.</i>			<i>Chemical Analysis.</i>		
Fine Gravel	...	6.88%	Moisture	...	7.22%
Coarse Sand	...	33.22 "	Loss on Ignition...	...	12.18 "
Fine Sand	...	20.96 "	Nitrogen	...	.44 "
Silt	...	9.04 "	Alumina Al_2O_3	...	.41 "
Fine Silt	...	7.70 "	Iron Oxide Fe_2O_3	...	5.00 "

Mechanical Analysis—cont.

Clay	...	...	2.02%
Moisture	...	...	7.22 „
Loss of Ignition	...	12.18 „	
Calcium Carbonate		31 „	
Stones (above 1/10")	14.9 „		
Fine Earth (less than 1/10")	...	...	85.1 „

Chemical Analysis—cont.

Manganese Oxide Mn_2O_3	...	Trace
Magnesium Oxide MgO	...	24%
Lime CaO	...	1.33 „
Carbonates	...	31 „
Potash K_2O	...	12 „
„ Available	...	03 „
Phosphoric Acid P_2O_5	...	40 „
„ Available	...	33 „
Sulphuric Acid SO_3	...	12 „

The soil rests on a subsoil of moist sandy gravel, which is found at about 4 feet below the surface. To the water in this substratum can be largely attributed the freshness which the older deeply-rooted trees maintained during the drought of 1921.

The high moisture content observed in the air-dry sample is attributable to the organic matter. The large proportion of the latter in a soil in which the three largest fractions (fine gravel, coarse sand and fine sand) comprise over 75% of the dry mineral matter can only be accounted for by the addition of heavy dressings of organic manure in the past. The percentage of calcium carbonate, although small, is nevertheless higher than might be expected in a soil of this type. The large proportion of organic matter explains the high nitrogen figure; in comparison with the "available" phosphoric acid, this cannot be regarded as excessive, but in conjunction with the relatively low percentage of "available" potash it may have contributed to the lack of stamina shown by many of the vegetable crops grown during 1921.

T. PARKER AND A. W. LONG.

The Greenhouse Grasshopper, *Tachycines asynamorus* Adel.

A PEST IN CONSERVATORIES AND PROPAGATING HOUSES

IN November last, the Bureau received from the firm's Horticultural Department specimens of an orthopterous insect, said to be responsible for considerable damage to young tomato plants and lobelias growing under glass, in the neighbourhood of Tulse Hill, S.W. Pending closer examination, the insect was reported to be a grasshopper of foreign origin and that steps for its eradication might be taken in accordance with the usual methods adopted for grasshopper control. In the meantime, the insect was identified by a London entomologist as the Japanese Grasshopper, *Diestrammena marmorata* de Haan, a determination with which we were unable to agree, especially in view of the fairly recent statement of B. P. Uvarov in *The Entomologists' Monthly Magazine*, September, 1921, p. 208. In discussing "A New Genus and Species of Orthoptera found in a Greenhouse in England," namely, *Chopardina importata* Uvarov, the author refers to another insect of a closely allied genus, *Tachycines asynamorus* Adel., and states that the latter has been many times incorrectly recorded under the name *Diestrammena marmorata* de Haan. A specimen of the Tulse Hill capture was submitted to Mr. Uvarov, at the British Museum, who identified it as *T. asynamorus*.

Several of the incorrect records mentioned by Mr. Uvarov have been made by entomologists who have afterwards corrected their determinations, and in each case the insect has been finally identified as *T. asynamorus*. The question of identity, the generic

differences, life-history, and a bibliography of the literature relating to the two insects are all thoroughly discussed in a German paper

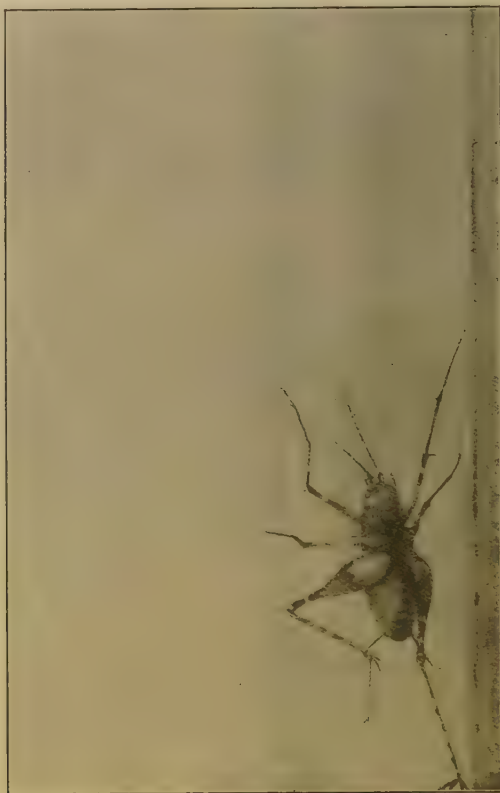


FIG. 24.

by R. Ebner,* on "The so-called Japanese Grasshopper of our Greenhouses," for reference to which, I am indebted to Mr. Uvarov.

* "Die sogenannten 'japanischen' Heuschrecken unserer Gewächshäuser (Diestrammena-Tachycines)." *Centr. Bakt. Abt.* 2, 1916, 45, pp. 587-594.

It was first recognised by Boldyrev, in 1913, that the so-called *Diestrammena*, then being reported from Germany, was identical with an insect that had been described by Adelung, in 1902, from specimens found in glasshouses in the neighbourhood of St. Petersburg. This led to a re-examination of specimens preserved in museums in Vienna and other continental centres, which resulted in the authoritative opinion that all the alleged European examples of *Diestrammena* should be referred to *Tachycines*. In general appearance both insects are similar. The colour is yellowish-green, with broad, dark-brown or black stripes on the body and legs, and this banded appearance is well seen in the photographs of *T. asynamorus*, Figs. 24 and 25. Striking features are the long delicate antennæ and the large, striped hind legs. The femur of the fore and of the middle legs, respectively, of both *Diestrammena* and *Tachycines* is armed at the apex with a strong movable spine, distinctly apparent in both photographs of the insect. It is upon the characters of the tibiæ of the hind legs that the separation of the two genera is mainly based. In *Diestrammena* the hind tibia is surmounted by rows of small spines of equal size, while in *Tachycines*, the stouter spines are unequal in size and are interspaced with spinules, features which are brought out in the photomicrograph of a portion of the tibia shown as Fig. 26.

This grasshopper is probably much more common than is generally supposed, its night-feeding habits preventing its detection. In the daytime the creature hides away in empty flower pots, behind and between boards, in the crevices of walls in the neighbourhood of heating apparatus, and in the many other possible places in a potting shed or glasshouse. Ebner speaks of the creature's extraordinary agility and states that it often springs to a vertical height of 40-50 cms. According to the writer's experience of the insect in captivity, the distance mentioned is a low estimate. It can move backwards or forwards with equal ease, and its spiny structure enables it to climb about among the leaves of growing plants. With reference to Ebner's observations, in which he says that the insect is unable to creep vertically up a glass surface, the writer's specimens were placed in a

rectangular vessel, built entirely of polished glass specially constructed for optical purposes, which did not prevent them climbing; as will be seen in Fig. 24. In this case the angles of the vessel were probably made use of, but it is an interesting fact that both insects were able to reach a position midway between the bottom and top of the vessel and remain there for many hours.

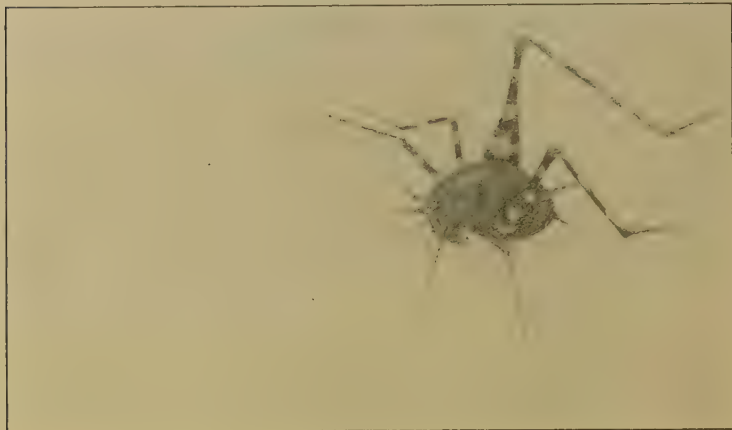


FIG. 25.

Our knowledge of the life-history of *T. asynamorus* is very incomplete. The female is said to lay from 1 to 50, or even 100 eggs, which are deposited during the night, and these, by means of the ovipositor, are placed below the surface of the soil. After hatching, the insect is active in all stages up to maturity, although the young larvæ are extraordinarily delicate.

There appears to be considerable divergence of opinion with regard to the feeding habits of this grasshopper. One authority, H. Wünn,* has claimed that, normally, it is a flesh-feeding insect,

* "Beobachtungen über eine in Mitteleuropa eingeschleppte Höhlenheuschrecke" (*Zeitschr. f. wiss. Insektenbiol.*, 5, 1909; through R. Ebner, *loc. cit.*

whilst other observers have shown that it is mainly a plant feeder ; it may, however, be described as unusually omnivorous in its choice of food material. There is good evidence for stating that the following plants are attacked and, if not destroyed, are seriously injured : the young shoots of Begonia, Cyclamen, Petunia, Nicotiana, Gloxinia, Lobelia and Chrysanthemum, as well as Pyrethrum and cucumber. The flowers and young leaves of exotic orchids, hyacinths and tulips, and the foliage of the Maidenhair fern are also included among the plants that have been known to form part of its diet. If for any reason suitable plants are not available,

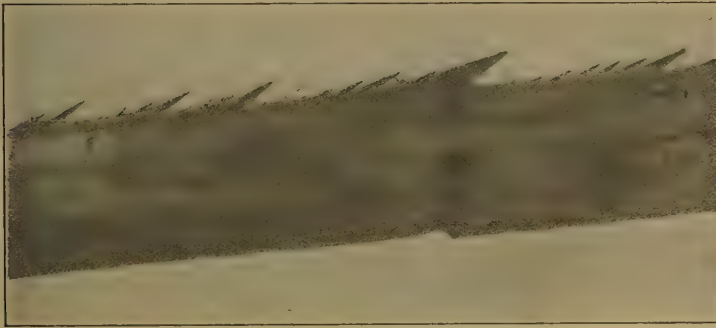


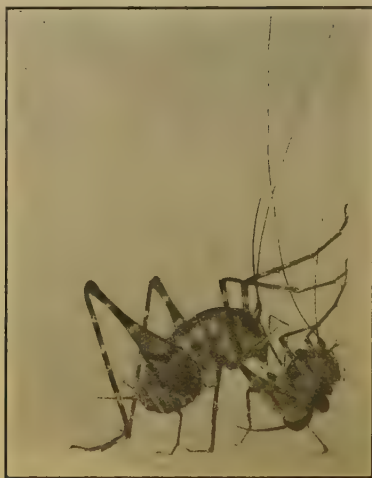
FIG. 26.

it will also feed on fruit, potatoes, porridge, biscuits, etc. In captivity in this laboratory the insect has fed on the petals of chrysanthemum, the leaves of carnation, and on the young shoots of hyacinths. Finally, the view of the first-mentioned authority with regard to its carnivorous nature receives some substantiation from the behaviour of one grasshopper to another, as illustrated by the writer's insects. The attack was not observed, but the wounds on the dying specimen were such as one could hardly believe to be self-inflicted, and the circumstantial evidence against the healthy insect was overwhelming. Whether the dead insect in due course would have been devoured by its former companion, or not, is unknown, as it was not left to the test.

Although this grasshopper has occurred in both the old world and the new, the location of its original home remains undetermined. It may have been always present in the gardens of Middle Europe where it has been found most commonly, overlooked by reason of its silent and secretive habits. Our client had imported plants from Belgium, as well as from Japan, and either consignment may have been responsible for the introduction of this insect to his greenhouses, whilst on the other hand the creature may have been present for many years in the conservatories and glasshouses of the district.

Readers requiring a full technical description of *T. asynamorus* may be referred to Dr. L. Chopard's recently published volume, *Orthoptères et Dèrmoptères*, in the "*Faune de France*," at present in course of publication.*

F. A. MASON.



* For the opportunity of consulting this new work the writer is indebted to the Editor of *Nature*.

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